

Colorado River Shortage Declaration – Planning, Responses, and Consequences

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End Users: Bureau of Reclamation; U.S. Department of Agriculture; Arizona Department of Water Resources; Arizona State Parks and Trails; Central Arizona Irrigation Districts; University of Arizona Water Resources Research Center; Arizona Department of Agriculture; Arizona Farm Bureau; Agribusiness and Water Council of Arizona; Pinal County Extension Office; Office of the Governor of Arizona; city, county, and tribal governments in Central Arizona; Maricopa Stanfield Irrigation and Drainage District; Central Arizona Irrigation and Drainage District

Additional Resource Support: Maricopa Stanfield Irrigation and Drainage District; Central Arizona Irrigation and Drainage District; College of Agriculture and Life Sciences, University of Arizona

Project Dates: 2017 – 2020

Summary of Impact

New economic analyses: This project explored the economic consequences of the declining water levels in Lake Mead for agricultural production and tourism in the Colorado River Basin. A hypothetical reduction of 300,000 acre-feet of water could result in losses up to \$66.7 million in gross farm-gate sales and between 270 – 480 full-and part-time jobs.

Increased understanding: Key findings were used by state legislators, the Arizona Department of Water Resources, and the Arizona Municipal Water Users Association to understand the economic impacts of reducing surface water supplies to agriculture in central Arizona.

Informing drought planning: Findings from this research project were used by various government agencies, businesses, and water irrigation districts during negotiations to develop Arizona's Drought Contingency Plan.

Problem Statement

Lake Mead's water levels are declining due to prolonged drought. In response, the Bureau of Reclamation asked Colorado Basin States to develop new drought contingency plans to reduce water usage from Lake Mead. Arizona's Drought Contingency Plan calls for significant reductions in surface water supplies for irrigated agriculture in Pinal County. While this action may lead to short-term cost savings, it may also reduce the sustainability of agricultural production in Central Arizona, causing negative economic impacts in other sectors. Reduced water supply may also negatively affect tourism industries at Lake Powell and Lake Mead. The economic effects of a Tier-1 Colorado River

shortage declaration will likely concentrate in rural communities, but little is known about which communities and sectors will be affected and how.

Research Focus

This project explored the effects of reduced surface water supplies on (a) crop production in Pinal County, (b) spillover economic effects to Arizona dairy production, (c) spillover economic effects to non-agricultural sectors in Pinal County, and (d) recreational demand around Lakes Mead and Powell.

Project Activities

Gathering stakeholder input: Meetings and interviews with project stakeholders to inform economic analysis.

Data collection analysis: Data collection, econometric modeling, and analysis; student training on data collection and analysis methods.

Sharing key findings and insights: Presenting findings on economic effects to interested stakeholders and the public

Project Outputs

Presentations:

- Water and Colorado Basin Agriculture. 2023. Invited Presentation for the Colorado Rivers Water Users Association Annual Conference, December 14, 2023, Las Vegas, NV Agriculture and Drought in Arizona. 2022. Presentation for The State Drought Monitoring Technical Committee. <https://new.azwater.gov/drought/mtc>
- Contribution of on-farm agriculture and agribusiness to the Pinal County economy. 2018. University of Arizona, Maricopa Agricultural Center. Invited by irrigations districts to present report findings. Attendees included the Director and other officials from the Arizona Department of Agriculture, Pinal County government, Maricopa Stanfield Irrigation and Drainage District, Central Arizona Irrigation and Drainage District, and the Arizona Farm Bureau.
- Economic Impacts of the Drought Contingency Plan on the Pinal County Economy. 2019. Pinal County Farm Bureau Annual Meeting, Casa Grande, Arizona. Invited by Arizona Farm Bureau to present research findings. Attendees were primarily agricultural producers, suppliers, farm lenders, conservation groups, and local government officials.
- A Colorado River Shortage Declaration: Planning, Responses, and Consequences. 2017. CLIMAS New Project Showcase. <https://www.youtube.com/watch?v=2fOUL9ZEZ7o>

Peer-Reviewed Publications:

- Frisvold, G. 2024. [Arizona policy responses to water shortage: Can they have an impact?](#) *Choices* 39: 1-7.
- Frisvold, G., J. Atla. 2024. Agricultural economic water productivity differences across counties in the Colorado River Basin. *Hydrology* 11:125. <https://doi.org/10.3390/hydrology11080125>

Frisvold, G., D. Duval. 2024. Agricultural water footprints and productivity in the Colorado River Basin. *Hydrology* 11:5. <https://doi.org/10.3390/hydrology11010005>

Bickel, A.K., D. Duval, G. Frisvold. 2019. Simple approaches to examine economic impacts of water reallocations from agriculture. *Journal of Contemporary Water Research & Education* 168:29-48. <https://doi.org/10.1111/j.1936-704X.2019.03319.x>

Reports:

Bickel, A., D. Duval, G. Frisvold. 2018. [Contribution of on-farm agriculture and agribusiness to the Pinal County economy](#). Tucson: University of Arizona Cooperative Extension.

- Nine news outlets reported on report findings in January and February 2019, including: Phoenix New Times, CBS Phoenix, Arizona Capitol Times, Associated Press, Arizona Daily Star, ABC Phoenix, Arizona Republic, Phoenix New Times, Arizona Republic

Master's Theses:

Hu, C. 2019. [Econometric Analysis of the Arizona Alfalfa Market](#). MS Thesis. Department of Agricultural & Resource Economics. University of Arizona.

Wu, X. 2019. [Recreation Visits to Lake Mead and Glen Canyon National Recreation Areas: A Replication Study](#). MS Thesis. Department of Agricultural & Resource Economics. University of Arizona.

Qiao, X. 2018. [Water Use and Climate Effects on Farm Profitability in the Colorado Basin](#). MS Thesis, Department of Agricultural and Resource Economics, University of Arizona.

Media Coverage:

[As Water Sources Dry Up, Arizona Farmers Feel the Heat of Climate Change](#). 2019. Civil Eats.

[District-Funded Study Says Farming Contributes \\$2.3 Billion to Pinal County](#). 2019. Phoenix New Times.

[Drought plan fight between Arizona farms and cities escalates](#). Tony Davis, Arizona Daily Star. (Frisvold was interviewed for background info by Tony Davis several times after this piece was published.)

[New Year, Same Challenges — What's Next for Arizona?](#) 2018. Arizona PBS Affiliate KUAT Arizona 360.

[Understanding Water Challenges for Agricultural Communities](#). 2018. Arizona PBS Affiliate KUAT Arizona 360.

Selected Scientific Findings:

Economic impact on outdoor recreation: Researchers analyzed the relationship between lake levels and recreational visitors at Lake Mead and Lake Powell. An earlier study found that from 1996-2011, higher water levels generally meant more visitors. This project extended the analysis timeframe to 1979-2017 and found the relationship less clear. For Lake Powell, the link between water level and visitor numbers was only true for the 1996-2017 period, but not the whole period. For Lake Mead, there was no clear link between water level and visitor numbers during any time period. This study considered the price of

gas as a factor, which significantly impacted visitor numbers: higher gas prices meant fewer visitors. This was true for both lakes and across all the time periods in the study.

Impacts of water reduction: The estimated economic impacts of changes in wheat, alfalfa, and cotton acreage resulting from a hypothetical reduction of 300,000 AF water (based on 2016 data), could lead to the following losses in Pinal County (Figure 1):

- \$63.5 million—\$66.7 million loss in gross farm-gate sales (~7% of on-farm agricultural sales)
- \$94 million—\$104 million loss in total county sales (farm and non-farm sales)
- \$31.7 million—\$35 million loss in county value added (value added combines net farm income, profits in other industries, employee compensation, and tax revenues)
- 270 – 480 full-and part-time jobs lost

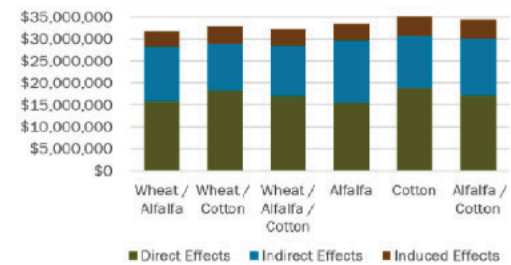
Impact on alfalfa and dairies: Based on econometric modeling, a 10% drop in Arizona alfalfa acreage from large-scale land fallowing would increase the state’s alfalfa price by 11.6%, although this would lessen over time. Alfalfa land fallowing could lead to price increases affecting Arizona’s dairies, the primary purchasers of the state’s alfalfa.

Economic water productivity: Researchers developed county-level, Colorado Basin-wide measures of agricultural economic water productivity (the economic value generated per acre foot of water); water footprints (how much water is used to produce crops); and irrigation cash rent premiums (how much farmers will pay for land with irrigation water). These measures inform conservation programs and compensation schemes.

- Crop sales were higher per unit of water in the Lower Basin than the Upper Basin. Sales averaged \$814/acre foot of water consumed (USD/AF) in the Lower Basin and \$131 USD/AF in the Upper Basin. Crop sales minus input costs averaged \$485 USD/AF in the Lower Basin and \$93 USD/AF in the Upper Basin.
- The blue water footprint was 1.2 AF/USD 1K (water per thousand dollars of crop sales) in the Lower Basin and 7.6 AF/USD 1K in the Upper Basin. Counties with higher water consumption per acre have a lower blue water footprint.

Variability in economic water productivity: This project investigated how different factors, such as climate, location, and farm characteristics affect the variation in agricultural economic water productivity (EWP) across Colorado River Basin counties. Researchers updated EWP measures using more detailed, localized data for the Colorado River mainstem.

Reduced Pinal County Value Added from Reduced Crop Production



Pinal County Job Losses from Reduced Crop Production

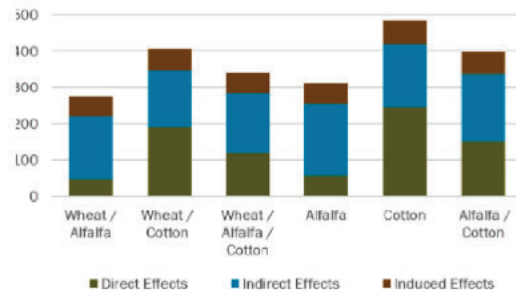


Figure 1: Economic impacts in Pinal County from a hypothetical reduction of 300,000 AF water

- EWP was highest in Lower Basin counties along the U.S. Mexico border (\$1033 USD/AF); second highest for other Lower Basin counties (\$729 USD/AF); and lowest in Upper Basin counties (\$168 USD/AF).
- Using improved irrigation technology did not have a statistically significant impact on EWP.
- Factors such as low population (remoteness) and more irrigated acreage per farm had negative impacts on EWP.
- Counties with the lowest EWP consumed 25% of the Basin’s agricultural water and only generated 3% of the Basin’s crop revenue.
- Warmer winter temperatures and greater July humidity were positively associated with EWP.
- Border Counties have greater access to labor from Mexico, enabling greater production of high-value, labor-intensive specialty crops.
- Counties on the U.S.-Mexico border had the highest water productivity, likely due to access to labor which enables increased production of high-value, labor-intensive specialty crops. When controlling for other factors, being on the Border increased a county’s EWP by \$570 USD/AF.

Leveraged Funding:

Supporting this project

- University of Arizona, College of Agriculture and Life Sciences Extension Strategic Initiative Proposal (\$26,978)
- Maricopa Stanfield Irrigation and Drainage District (\$5,000)
- Central Arizona Irrigation and Drainage District (\$5,000)

Societal Impacts by Category

Conceptual:

- AZ State Senator Kirsten Engel consulted George Frisvold about the effect of technology requirements on water conservation in response to legislative debates over the Drought Contingency Plan.
- Local irrigation districts in Pinal County and the Arizona Department of Agriculture requested the analyses conducted by this project. The final project report was shared on the Arizona Farm Bureau’s and Pinal County’s websites for public access. Nine news outlets reported research findings in January and February 2019.

On policy impact:

You might be talking about a policy in your research, but if policy makers are not calling you up, then you're not having that direct policy influence. When they do, you must be able to respond quickly.

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George Frisvold, CLIMAS

- The Colorado River management division at the Arizona Department of Water Resources requested a copy of a presentation that shared new findings from this research. They wanted to use findings to inform Colorado River negotiations with different states.

On use of findings:

I asked George to summarize his study findings so we could add them to the 2022 Arizona Drought Preparedness annual report. This report is not only intended for the public and general audiences, but it's also sent to the Governor's office. It is our way of keeping the Governor's office up to date about everything drought that we do in the state. That's one way that we shared information from this project with leadership and policymakers.

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Nemesis Ortiz-Declet, Arizona Department of Water Resources

Capacity Building:

- The Arizona Department of Water Resources requested a summary of research findings to include in their 2022 Arizona Drought Preparedness annual report. ADWR uses the report to update the public and the Governor's office on their drought-related work.
- This project trained three graduate students on economic analysis, resulting in three M.S. theses. The project provided continued support for two early career scholars.

Instrumental:

- The Arizona Municipal Water Users Association developed a briefing memo using study results to inform their

positions on the state's Drought Contingency Plan.

- Negotiations over Arizona's 2018-2019 Drought Contingency Plan negotiations were contentious. Urban water providers and agricultural interests disagreed issues like the costs of water cutbacks on Pinal County agriculture and appropriate mitigation measures. Both urban and agricultural sides relied on research findings from this project in their negotiations.
- Economic impact estimates from the study were used in testimony over mitigation funds for Pinal County agriculture.

On use of findings:

Presentations from this research provided a way to have new and reliable information based on research, that policymakers could use when they talk about the Colorado River situation, and negotiations with different States

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Nemesis Ortiz-Declet, Arizona Department of Water Resources